Surface and Ground Water Quality Monitoring of Chitrakoot During Amavasya Occasion Day

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ABSTRACT

The present study was carried out as monitoring of physico-chemical and biological parameters of ground and surface water bodies of Chitrakoot in order to know or check their water quality for drinking or other purposes. Monitoring was performed in March, 2010 at an Amavasya occasion day. The parameters investigated were temperature, pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), calcium hardness (CaH), magnesium hardness (MgH), calcium, magnesium, alkalinity, chloride, sulphate, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total coliform (TC). Hardness and conductivity values were higher than their prescribed standard in all surface and ground water samples. Besides BOD, COD, and TC values were exceed only in surface water samples than that of their permissible limits while alkalinity and TDS values were higher than their prescribed standard in all ground water samples. Except alkalinity and TDS in ground water samples, BOD, COD and TC in surface water samples, hardness and conductivity in both surface and ground water, entire monitored parameters were recorded within their permissible limit prescribed by BIS, WHO and ICMR.

Keywords: Amavasya occasion day, Ground and surface water quality, Hardness, Alkalinity, Conductivity, BOD, COD and Total coliform.

INTRODUCTION

Water is an odorless, colorless, and tasteless compound that is also considered as a renewable resource. Due to the a renewable resource it is continually recycled through the water cycle which is also known as the hydrologic cycle. Water is recycled through the processes of evaporation and precipitation. Even though water is constantly being recycled, only a small amount is available for use by humans. Because major water sources on the earth are saline water (99%) source and gives the brackish taste to the water which is available as seas and oceans. Remaining 1 percent of water source includes the fresh water on the earth i.e. surface water and ground water (Gupta *et. al.*, 2009) Surface water and ground water are interconnected in

that one water source is used to recharge the other. Surface water is a useable freshwater, it is located in rivers, ponds, lakes, reservoirs, dam, wetlands, etc. while ground water is contained in the pores between soil particles and gravel or in cracks in fractured rocks under the soil surface. When all of the pores are filled with water, it is referred to as aquifers which are known as dug wells, stairs wells, bore well, hand pump, etc. Surface and ground water are likely used many purposes for human such as drinking, bathing, washing, watering animals, recreation, manufacturing and irrigation, etc. In addition to human use, surface and ground water is used for many different aquatic plant and animal species that require clean water for their survival. Recent time, due to the unwanted growth of population, urbanization and industrialization developments, the above sources of water have become increasingly contaminated. In the present study, monitoring and analysis of physico-chemical and biological parameters were carried out of some selected surface and ground water stations of Chitrakoot at Amavasya occasion day.

STUDY AREA

Chitrakoot is a holy place owing to lord Ram which is known as Karam Bhumi of lord Ram. It is situated in M.P. and U.P. states. It is believed that lord Ram passed here about 12 here out of fourteen years during his exile period with his wife Sita and brother Laxman. It is also place of lord Kamtanath is known as Kamadgiri hill where lord Ram obtained the fulfill wish from him for killing the Rakshasha. Considering its faith, a lack of pilgrims visit here for obtaining the full filled wish from lord Kamtanath (by Kamadgiri hill Parikrima) on specially occasion Amavasya. Before going to Parikrima, they bath in the river Mandakini and offer their impurity as dirtiness of body and warship goods to the river Mandakini. After returning the Parikrima, mostly pilgrims take the rest along with river Mandakini as temporary settlement and they use the water for drinking and making food nearly attached ground water (hand pumps). So keeping the above observations, monitoring and analysis of surface and ground water quality of some selected stations of Chitrakoot was necessary in order to know or check their water quality drinking or other purposes for pilgrims so that water quality may be improved for safe and healthy life of the pilgrims and surrounding population.

MATERIALS AND METHODS

Physico-chemical and biological monitoring of surface water (SW) and ground water (GW) of Chitrakoot were carried out, during March, 2010 at Amavasya occasion day. 10 water samples (Five (5) surface water and five (5) ground water samples) were collected at selected points of surface and ground water bodies of Chitrakoot. Geographical locations of selected stations of surface and ground water of Chitrakoot were also taken by Global Position System (GPS). About two liter water samples were collected from both selected surface and ground water stations. Water samples were collected in pre-cleaned polypropylene bottles with necessary precautions (APHA-AWWA, 1992). Temperature and DO were analysed at the sampling stations while other parameters were determined in the laboratory. Samples for DO, BOD and TC were taken in BOD bottles. AR grade chemicals obtained from Qualigen, Hi-Media, E-Merck, etc. and borosilicate grade glasswares obtained from Shott Duran were

used in the field and laboratory for above analysis. All analysis were carried out using standard methods for examination of water and wastewater (APHA-AWWA, 1992).

RESULTS AND DISCUSSION

Details of the sampling stations as code of sampling stations, sampling locations along with their geographical locations were mentioned in table 1. Results of the physicochemical and biological monitoring of surface and ground water samples of Chitrakoot were mentioned in table 2 and figures 1-9**.** The results of monitored parameters were also compared with their recommended standards (Table-1) prescribed by BIS (1990) WHO (1991) and ICMR (1975).

The temperature is most important parameters of SW and GW which shows the effect on physico-chemical parameters of water because it is responsible for decreasing or increasing ability of physico-chemical parameters. In SW bodies, it play positive role for photosynthesis reaction in aquatic plant at elevated and it also play negative role at elevated temperature on taste of water because portability of all gases are expelled at higher temperature while GW sample, at warmer temperature, solubility of calcium carbonate is decreased, at colder temperature, solubility of barium sulphate, stronoum sulphate and silca are decreased in GW samples (Rao and Rao, 2010). It is clear from table 2 that temperature ranged from 20 to 21.5 ^{0}C in SW while from 25 to 26 ^{0}C in GW. Maximum temperature was recorded in GW samples than that of SW samples due to the high depth of GW (Fig.1). The temperature always increases with the depth of the sources of samples.

pH value was recorded from 7.2 to 7.5 in SW while from 7.6 to 7.8 in GW (Table 2). Results of pH values indicated that water was almost alkaline at all sampling stations of SW and GW. Alkaline pH was recorded due to the high extent of limestone hillocks at both sides of river Mandakini (SW) as well as GW samples.

Turbidity value was recorded from 1.0 to 2.0 NTU in GW while from 15 to 30 NTU in SW (Table 2 and Fig.2). Minimum values were found in GW samples due to the high depth of GW. Besides, no contaminations as any drainage or leaching of solid waste along with GW samples reach in GW stations. While other side, maximum values were found in SW samples due to the mass bathing activities take place at Amavasya occassin day and offer the warship goods such as flower, oil, ghee, floor, cloth, cotton, etc. by the pilgrims. All GW turbidity values were recorded within permissible limit as per their recommended standard while all surface water samples were recorded exceed as per their prescribed standards (Table 3).

Electrical conductivity (EC) always assume of water capacity to convey electric current and it is directly related to its dissolved minerals content as cation and anion. Table 3 shows that Electric conductivity (EC) was found in the range of 555 to 580 μmho/cm in SW while 880 to 920 μmho/cm in GW. All values of EC of both surface and ground water were higher from their permissible limit. Higher value of EC was recorded in both waters due to the present of higher dissolved mineral concentration in both water.

Total dissolved solids (TDS) is directly related to electrical conductivity (EC). It is also estimated by sum of the extent of cation and anion present in water. Extent of cation and anion reach in water through internal erosion

and weathering of rocks and anthropogenic activities. TDS were found in the range of 388-406 mg/l in SW samples while 572-406 mg/l in GW samples (Fig.3).

Hardness is originally defined as the soap consuming capacity of water sample. The soap consuming capacity of water sample occurs mainly due to the presence of Ca^{++} and Mg^{++} salts as $CaCO_3$ (as carbonate, bicarbonate, sulphate, chloride). Total hardness value was found to be in the range of 376 to 390 mg/l in SW while 494 to 528 mg/l in GW (Fig.4). Value of total hardness of all SW and GW sample was higher than its permissible limit 300 mg/l. Since the area is rich in various mineral and ores and known as store house of limestone rocks so the water get more calcium and magnesium salts owing to their more solubility under anaerobic conditions. Similar findings were also reported by Gupta *et.al* .

Sum of the **Ca^{++} and Mg^{++} hardness** value always correlates the total hardness value. Ca^{++} and Mg^{++} hardness values were found to be in the range of 238 to 245 mg/l and 134 to 145 mg/l in SW samples respectively while 324 to 354 mg/l and 170 to 181 mg/l in GW samples respectively(Fig.5). It is obvious of the above findings that values of Ca^{++} and Mg^{++} hardness were recorded owing to presence of lime stone, calcite, dolomite, etc. rocks in plenty in the study area.

Values of **calcium and magnesium** were recorded in the range of 95.2 to 98.0 mg/l and 32.7 to 35.4 mg/l in SW samples respectively, while 131 to 142 mg/l and 41.3 to 44.0 mg/l in GW samples respectively (Fig.6). Extent of calcium and magnesium always correlates with respect to calcium and magnesium hardness values in any water samples. Both calcium and magnesium were found more than their permissible limits (Table 3). As calcium and magnesium hardness values were high so the extent of calcium and magnesium will be high in the both waters. Such waters may give harmful effect for the users because more extent of calcium and magnesium lead to cause of kidney stone formation problem and jointness disease in foots upon the users. Besides negative effect as scaling in water heater, pipe, boiler etc (Garg, 2003).

Table 2 showed that **Chloride (Cl^-)** was found in the range of 65 to 85 mg/l in SW while 20 to 38 mg/l in GW. Chloride is second most inorganic anion after bicarbonate anion. This anion is about to produce of hardness in water. High concentration of chloride gives the bitter taste in water due to DO concentration reduces and salinity increases in water (Manjappa and Naik, 2007). All values were found safe within their permissible limit (Table 3).

Alkalinity is mainly found in form of carbonate, bicarbonate and hydroxide. It was found in concentration range of 160 to180 mg/l in SW while 260 to 316 mg/l in GW (Table 2). High concentration of alkalinity was recorded in the form of HCO_3^- in water which is justified on account of much occurrence of carbonate rocks therein.

Sulphate normally reach in SW from the more used the soap and detergent by the user. While other side in GW, it mostly enter through leaching of sulphate rocks or ores. It was found in the range of 22 to35 mg/l in SW while 14 to 20 mg/l in GW(Fig.8). Values of both samples was recorded within their permissible limit (Table-3).

Dissolved oxygen (DO) is a most important parameter for aquatic life which presence in surface water than that of ground water. There are main sources of oxygen in water- diffusion

from air and photosynthesis activities. Non polluted water is generally saturated with dissolved oxygen but when presence of oxygen demanding pollutant such as organic waste causes rapid depletion of DO from water. Besides oxidisable inorganic substances i.e. ammonia, ferrous iron, hydrogen sulphide, nitrites, etc. are also cause decrease of DO from water. It is obvious from table 2 that dissolved oxygen (DO) ranges from 6.4 to 8.0 mg/l in SW while from ND to 1.5 mg/l in GW. Maximum values were recorded in 2,.3 and 4 in SW samples which might be due high flow of these station in comparison to 1 and 5 station of SW. While other words, values of dissolved oxygen (DO) in GW samples were found nil or low due to the high depth and developed under ground situation result in no or little possibility of free aeration or anaerobic condition in the GW samples.

Table 2 showed that **chemical oxygen demand (COD)** was quite low within its permissible limit in GW samples than that of SW samples. Low limit of COD in GW showed that no inorganic and organic pollutants reach from any sources. While other side in all SW samples, value of COD was quite high owing to mass bathing discharge which directly reach in river and increases the COD value. Value of COD was recorded from 16 to 70 mg/l in SW while 3.2 to 4.8 mg/l in GW (Table 2) .

Biochemical oxygen demand (BOD) value was recorded from 12.2 to 44.0 mg/l in SW while 1.8 to 2.6 mg/l in GW (Table 2 and Fig.8). Extent of BOD was exceeded in SW while under limit in GW samples. Higher limit in SW samples was noticed due to presence of point pollution load as big and small drainage joins the river and thus contributes more value of BOD. More ever, mass bathing activities run on Amavasya occasion day consequently indicating high values of BOD in river (SW).

Extent of total coliform (TC) was almost high in case of all stations of SW while low extent was recorded in GW samples. Low extent was noticed only due to the absence of point pollution load in GW while high extent was noticed due to the presence of mass bathing activities, discharge of sewage and domestic waste in the river (SW) (Deswal and Chandna, 2007). TC value was recorded from 312 to 356 MPN/100ml in SW while from 10 to 24 MPN/100ml in GW (Table 2 and Fig.9). High value of TC in SW indicated unfitness of the river water for drinking purpose of the user.

CONCLUSIONS

Finding of the study area indicated that area is rich in aforesaid mineral and ores result in hardness and conductivity values were higher than their prescribed standard in all surface and ground water sample. Besides BOD, COD, and TC values were exceed only in surface water samples than that of their permissible limits while alkalinity and TDS values were higher than their prescribed standard in all ground water samples. High values of hardness, alkalinity, TDS and conductivity parameters were noticed due to the naturally or geogenic sources of aforesaid selected area. Similarly high values of BOD, COD and total coliform were noticed in surface water samples due to the occasionally offering goods by the large number of pilgrims. Except alkalinity and TDS in ground water samples, BOD, COD and TC in surface water samples, hardness and conductivity in both surface and ground water, entire monitored parameters were recorded within their permissible limit prescribed by BIS, WHO and ICMR.

Table-1: Details of Sampling Stations

	S. No.	Sampling Station Code	Location	Latitude and Longitude
GROUND WATER	1	SW-1	It sampling station is known as Sphatikshilla (SS). It is a upstream station, 03 Km in the south of Chitrakoot	25^0 8'46.5" N and 80^0 51' 25.1" E
	2	SW-2	It sampling station is known as Arogdham (AD). A midstream station, 2.0 Km in the south of Chitrakoot	25^0 9' 25.9" N and 80^0 51' 46.7" E
	3	SW-3	It sampling station is known as Jankikund (JK). It is a midstream station,1.5 Km in the south of Chitrakoot	25^0 9'31.6" N and 80^0 51' 51.4" E
	4	SW-4	It sampling station is known as Pramod Van (PV). It is a midstream station,1.0 Km in the south of Chitrakoot	25^0 10'15.2" N and 80^0 52' 1.1" E
	5	SW-5	It sampling station is known as Ramghat (RG), It is a downstream station, 0.1 Km in the north of Chitrakoot	25^0 10'40.8" N and 80^0 52' 15.9" E
SURFACE WATER	6	GW-1	About 200 meter away from Sphatikshila sampling stations	25^0 8' 55.5" N and 80^0 51' 30.5" E
	7	GW-2	About 150 meter away from Arogdham sampling stations	25^0 9' 19.5" N and 80^0 51' 50.4" E
	8	GW-3	About 100 meter away from Jankikund sampling stations	25^0 9' 34.2" N and 80^0 51' 54.5" E
	9	GW-4	About 100 meter away from Pramodvan sampling stations	25^0 10' 18.5" N and 80^0 52' 3.3" E
	10	GW-5	About 200 meter away from Ramghat sampling stations	25^0 10' 25.5" N and 80^0 52' 7.0" E

Table 2: Results of Physico-Chemical and Biological Analysis of Surface and Ground Water

Sampling Stations / Parameters	Surface Water					Ground Water				
	SW-1	SW-2	SW-3	SW-4	SW-5	GW-1	GW-2	GW-3	GW-4	GW-5
Temperature(^{0}C)	20.0	20.5	21.0	21.5	21.5	25.0	25.5	25.5	26.0	26.0
pH	7.4	7.4	7.4	7.5	7.2	7.6	7.7	7.8	7.8	7.8
Turbidity(NTU)	15	22	20	16	30	01	02	02	02	01
EC(μmhocm^{-1})	580	555	573	557	563	880	884	908	920	914
TDS (mg/l)	406	388	401	390	394	572	575	590	600	592
TH as$CaCO_3$ (mg/l)	390	376	382	372	380	494	502	518	528	522
Ca hard. as $CaCO_3$ (mg/l)	245	240	243	238	242	324	330	342	354	340
Mg hard. as $CaCO_3$ (mg/l)	145	136	139	134	138	170	172	176	174	181
Ca^{++} (mg/l)	98	96	97.2	95.2	96.8	131	132	138	142	136
Mg^{++} (mg/l)	35.4	33.2	33.9	32.7	33.7	41.3	41.5	44.0	42.0	43.9
Alkalinity (mg/l)	180	165	176	160	168	260	274	316	278	290
Chloride (mg/l)	75	70	72	65	85	20	35	38	30	28
SO_4^{--} (mg/l)	28	34	22	24	35	18	20	14	16	18
DO (mg/l)	6.4	7.2	7.5	8.0	5.2	1.2	1.5	ND	1.4	ND
BOD (mg/l)	12.2	36.0	30.4	18.5	44.0	2.0	3.2	1.8	2.6	1.9
COD (mg/l)	16	54	46	28	70.0	4.2	4.8	3.8	4.6	3.2
TC (MPN/100ml)	312	344	340	320	356	10	14	24	20	16

Table 3: Drinking Water Quality Standards

Parameters	Maximum Permissible Limit		
	World Health Organisation (WHO,1994)	Bureau of Indian Standard	Indian Council of Medical Research (ICMR,1975)
pH	7.0-8.5	6.5-8.5	7.0-8.5
Turbidity (NTU)	10	5	10
EC (μmho/cm)	500	-	500
TDS mg/l	500	500	-
TH as $CaCO_3$ (mg/l)	300	300	300
Calcium (mg/l)	75	75	75
Magnesium (mg/l)	30	30	30
Alkalinity (mg/l)	200	-	200
Chloride (mg/l)	200	-	200
Sulphate (mg/l)	250	-	-
DO (mg/l)	4-6	-	5.0
BOD (mg/l)	6.0	-	5
COD (mg/l)	10	-	-
TC (MPN/100ml)	50/100ml	-	50/100ml

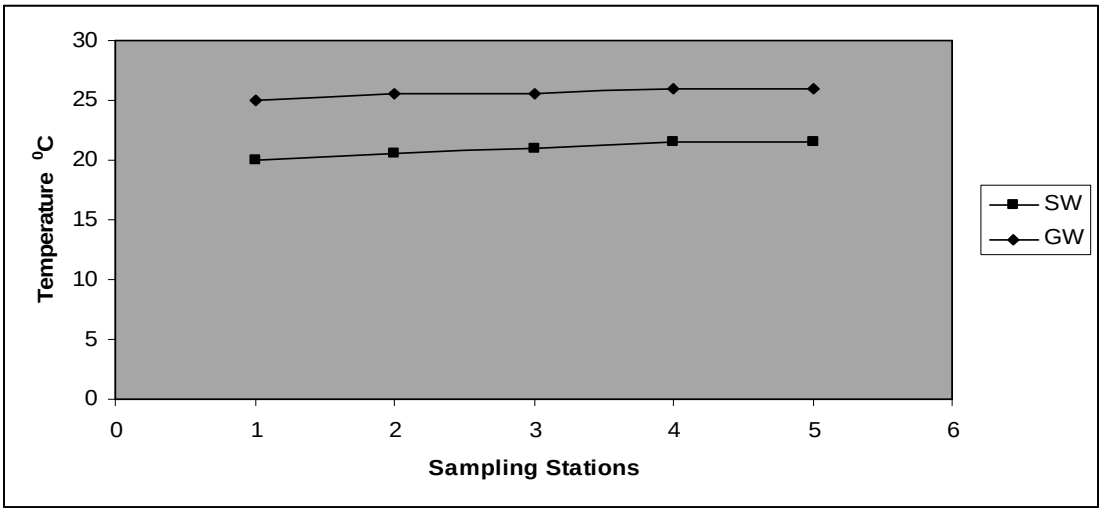

Fig.1: Temperature values of different surface and ground water stations of Chitrakoot

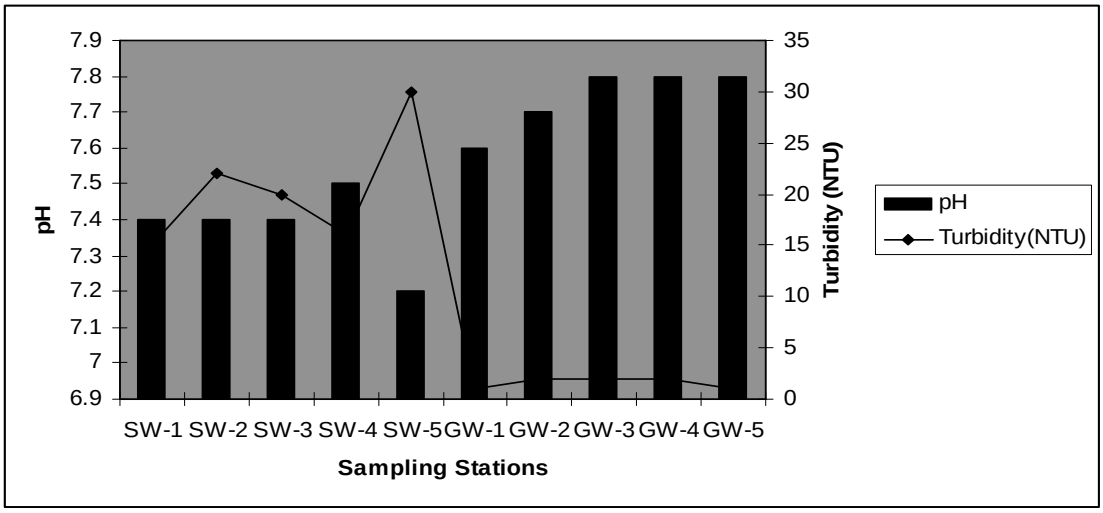

Fig.2: pH and turbidity values of different surface and ground water stations of Chitrakoot

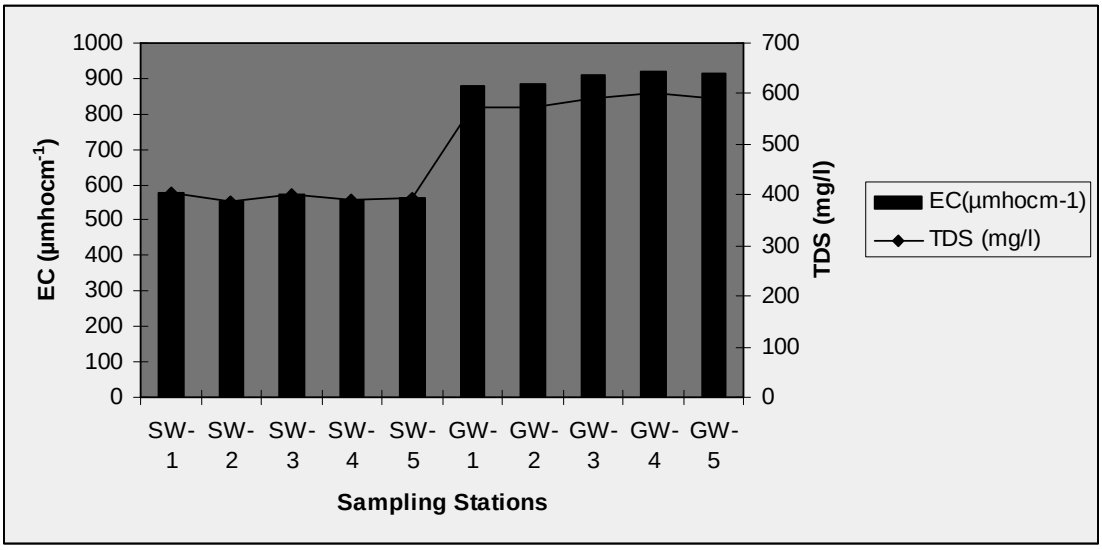

Fig.3: EC and TDS values of different surface and ground water stations of Chitrakoot

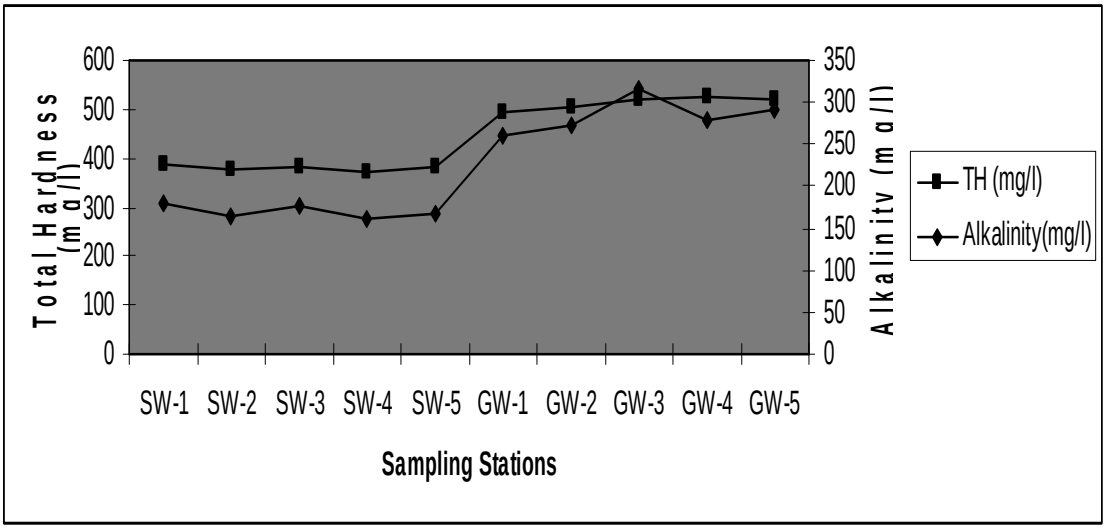

Fig.4: Total hardness and alkalinity values of different surface and ground water stations of Chitrakoot

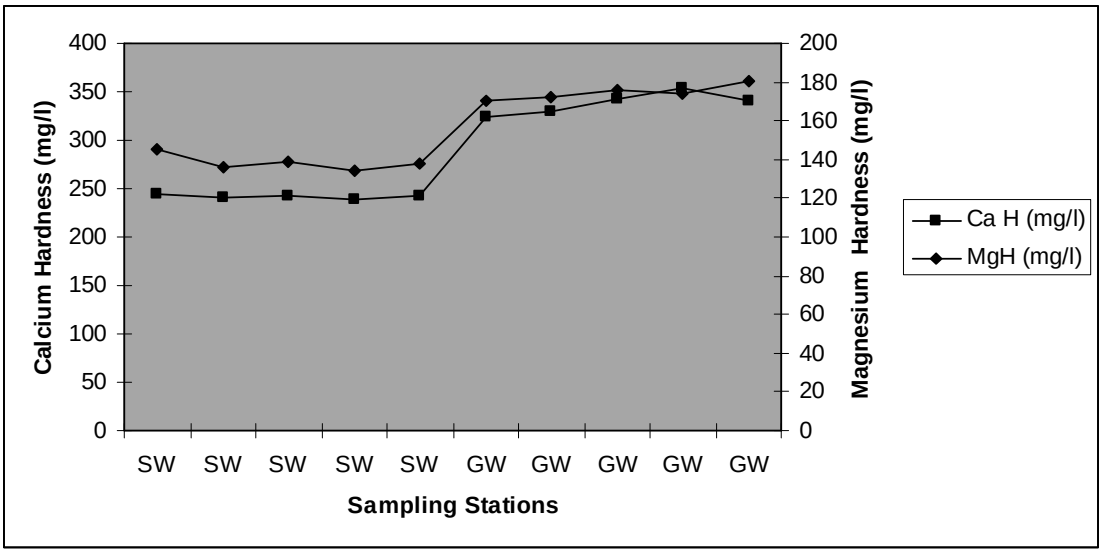

Fig.5: Calcium hardness and magnesium hardness values of different surface and ground water stations of Chitrakoot

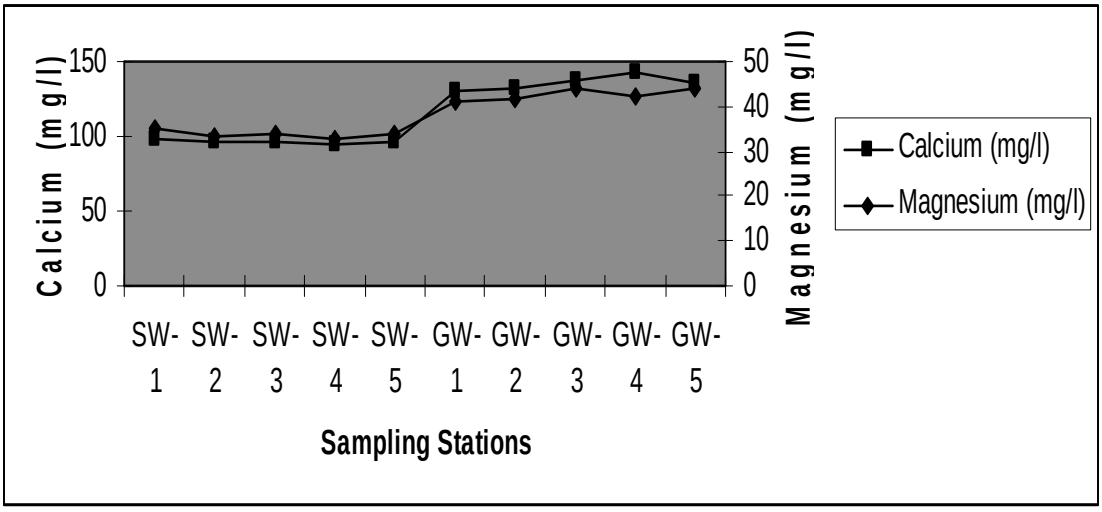

Fig.6: Calcium and magnesium values of different surface and ground water stations of Chitrakoot

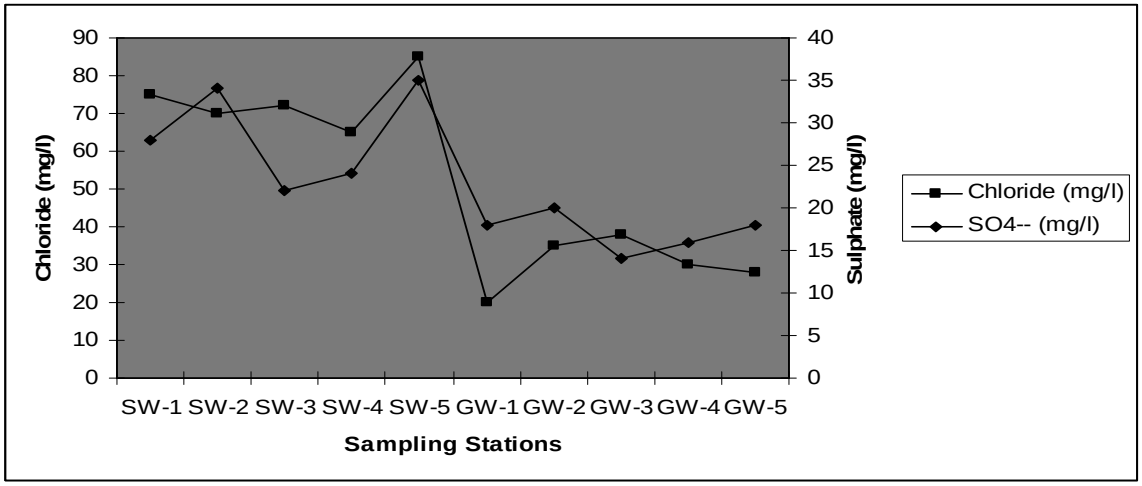

Fig.7: Chloride and sulphate values of different SWand GW stations of Chitrakoot

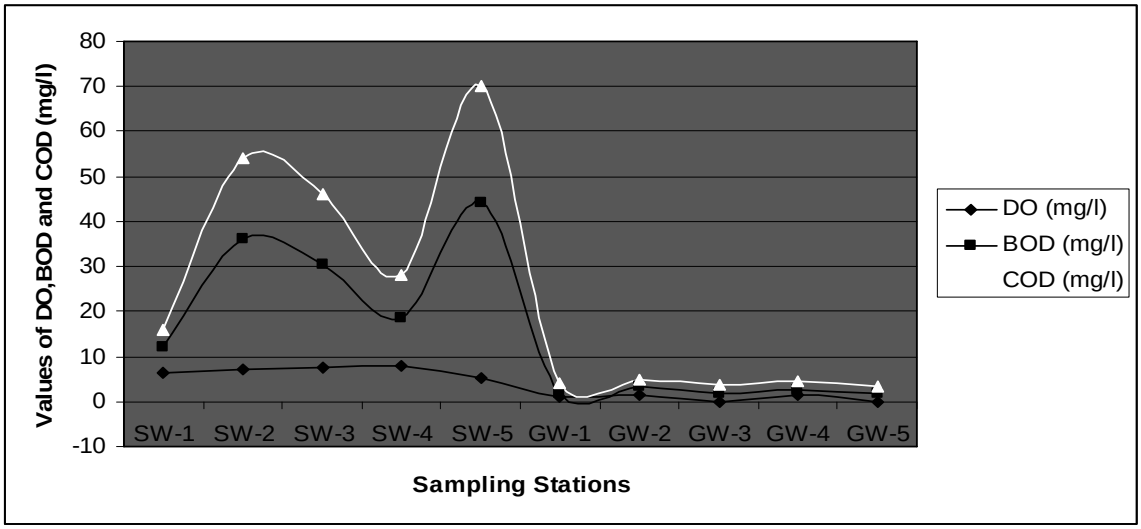

Fig.8: DO, BOD and COD values of different SWand GW stations of Chitrakoot

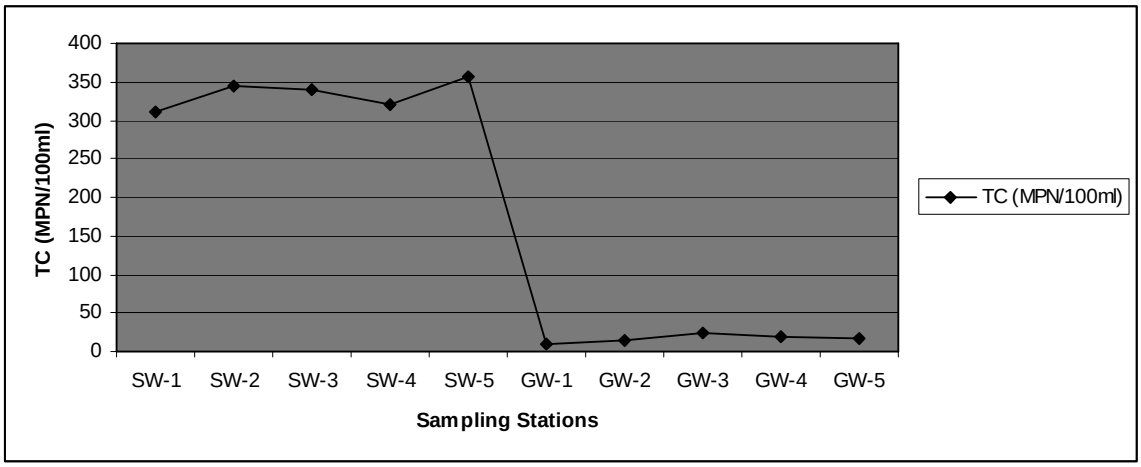

Fig.9: TC values of different surface and ground water stations of Chitrakoot

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